



Hierarchical Control for Constrained Multi-timescale Energy Management

Award #: CNS-1849500, Award Date: 2/21/2019

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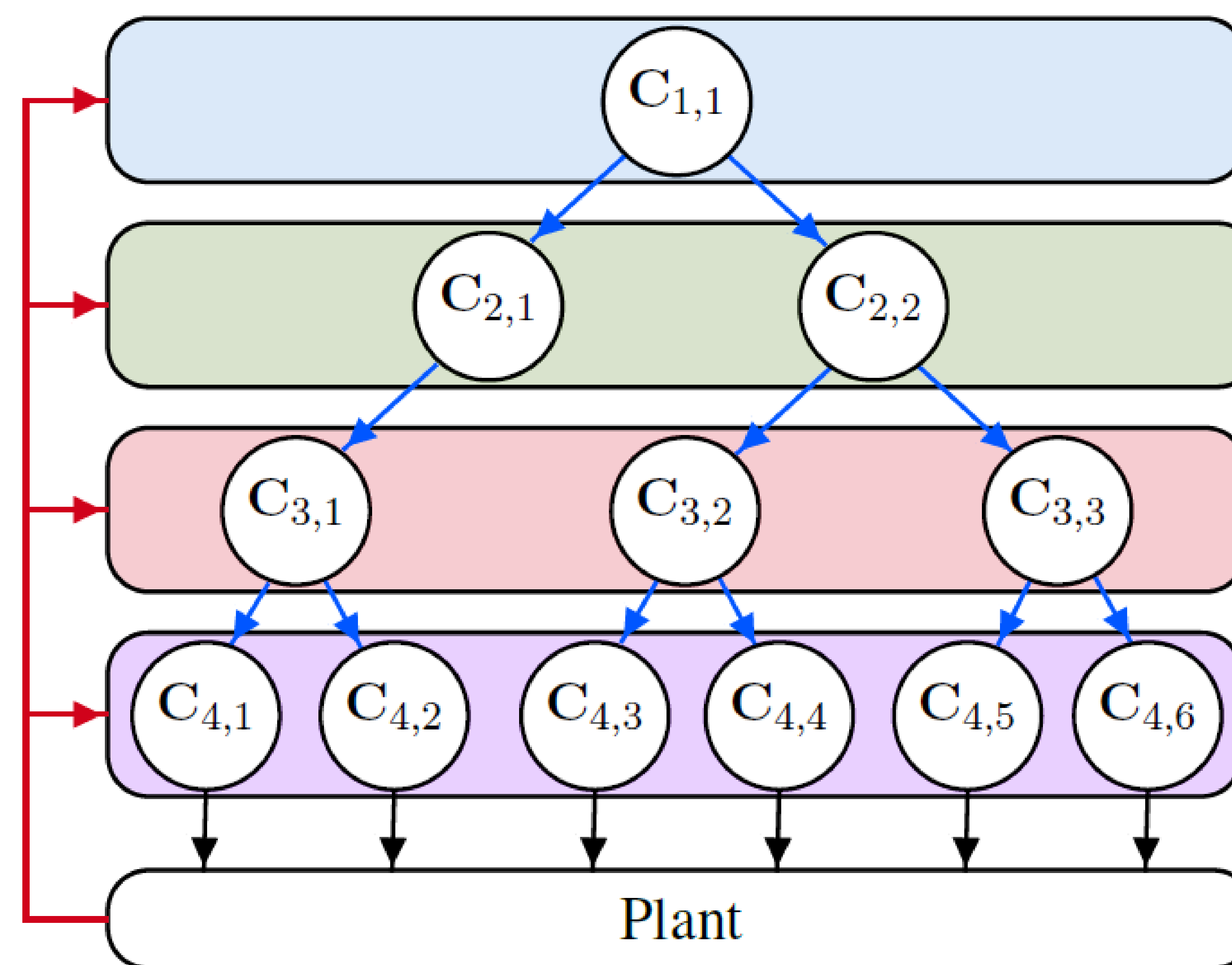
Challenge:

- Complex, multi-timescale CPS need **hierarchical control** approaches that **guarantee performance and safety**

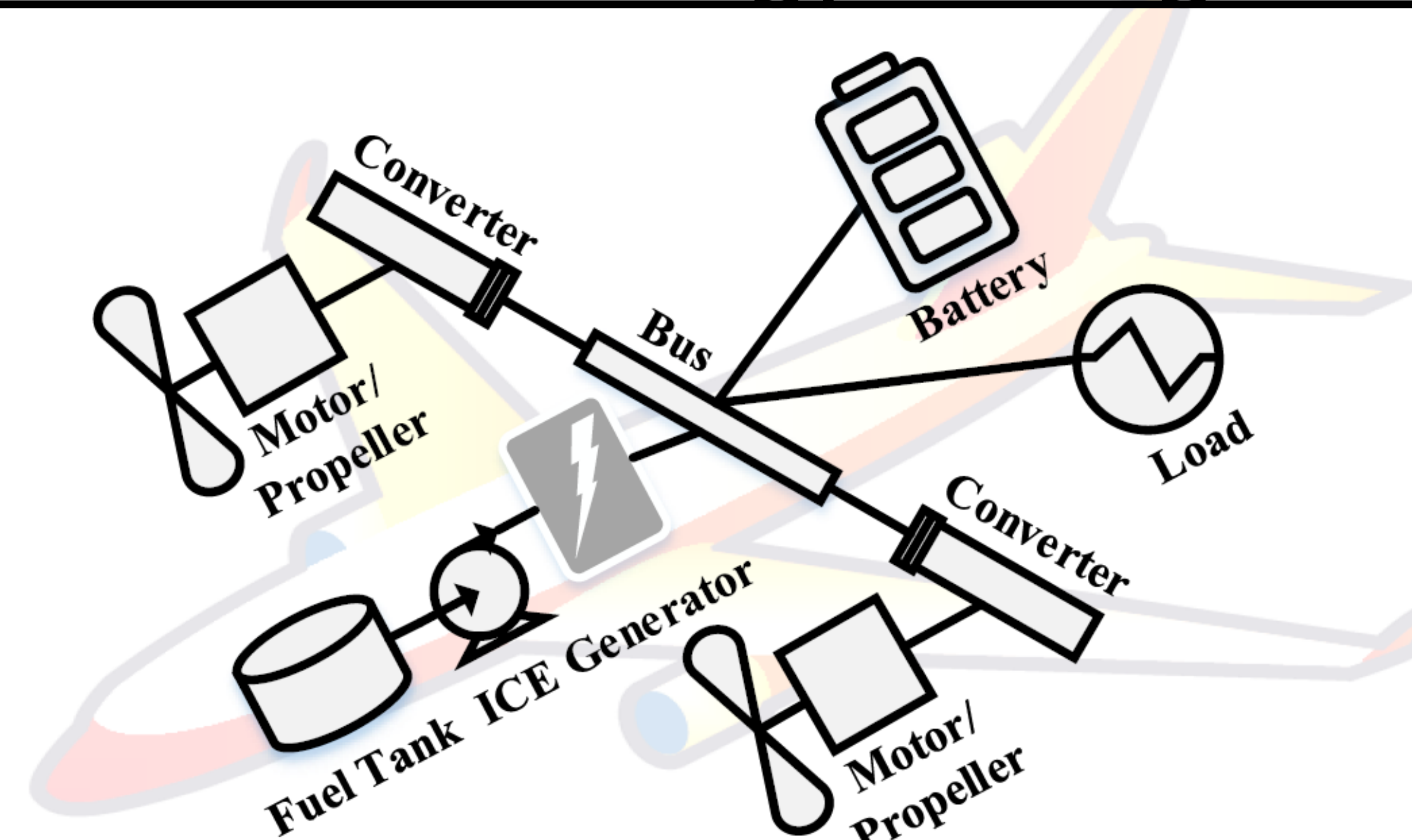
Solution:

- **Set-based hierarchical MPC**
 - New, constraint-based coordination mechanisms
 - Guaranteed constraint satisfaction
- **Set-based hierarchical control architecture design**
 - Accounts for dynamics and operating constraints

4-level hierarchical MPC



For aircraft energy management



Scientific Impact:

- **Set-based techniques** for control, estimation, and reachability analysis
 - Constrained zonotopes** set operations/reduction
- **New complex system decomposition techniques**

Broader Impact:

- Higher performance, more efficient, and safe **aircraft energy management**
 - Increased electrification
 - Overcome thermal bottlenecks
- Demonstrated 3-4 orders of magnitude reduction in set computation time
 - Enable **set-based approaches for complex systems**